REMARKS

Enclosed herewith is a Substitute Specification in which the specification as filed has been amended in various places to correct typographical and grammatical errors, and also to add section headings. In addition, the specification as filed has been amended to add a description of Fig. 2.

In support of the above enclosed herewith is a copy of the specification as filed marked up with the above changes.

The undersigned attorney asserts that no new matter has been incorporated into the Substitute Specification.

The claims have been amended to more clearly define the invention as disclosed in the written description. In particular, the claims have been amended for clarity.

The Examiner has rejected claims 1, 2 and 4 under 35 U.S.C. 102(b) as being anticipated by U.S. Patent 4,790,014 to Watanabe et al. The Examiner has further rejected claim 3 under 35 U.S.C. 103(a) as being unpatentable over Watanabe et al. in view of U.S. Patent 5,230,022 to Sakata.

The Watanabe et al. patent discloses a low-pitched sound creator in which low-frequency components of a sound signal are selected to derive a low-pitched sound signal, a key of the low-pitched sound signal is lowered so that a very-low-pitched sound signal is derived. The very-low-pitched sound signal may then be output to a separate loudspeaker (Fig. 8), combined with the

original sound signal (Fig. 4), or combined with the low-pitched sound signal (Figs. 11 and 15).

The Examiner now states that Watanabe et al., with reference to Fig. 15, discloses an input for receiving an input signal (e.g., SR), a first signal path (adder 9F, LPF 19) and a second signal path (operation circuit 10, LPF 4, key converter 5, switch 11), whereby the first signal path comprises a filter means (LPF 19) and creating means (LPF 19) for creating an adapted signal with a lower frequency part than the input signal (SR), combining means (adder 20), and the second signal path comprises delay means (inherent that there will be a delay between 10 and 20 such as filter 4).

Applicant submits that the Examiner's analysis of Watanabe et al. does not make any sense. In particular, while LPF 19 may be considered the filter means of the claimed invention, it should be apparent that a filter, and in particular, a low-pass filter cannot be "creating means for creating an adapted signal with a lower frequency part than the input signal". Rather, a low-pass filter merely passes those portions of an applied signal below a particular threshold frequency.

If anything, the first path of the claimed invention may be compared to the path including the operation circuit 10, LPF 4, key converter 5 and switch 11. To that end, the filter means would then correspond to LPF 4, and the creating means would correspond

to the key converter 5. Then, the second path of the claimed invention could be compared to the path including the LPF 19 (it being assumed that the LPF has some delay). However, as opposed to some random delay as is apparent in Watanabe et al., the delay means of the subject invention compensates for the delays in the first signal path. In Watanabe et al. it should be apparent that LPF 4 and 19 are substantially equivalent and would exhibit substantially the same delay. As such, there is nothing to compensate for the delay of the operation circuit 10 and the key converter 5.

Applicant contends that Watanabe et al. neither discloses or suggests delaying an unprocessed audio signal in a second path by an amount to compensate for the delay of the audio signal subjected to the filter means and the creating means in a first signal path.

Applicant submits that in the normal teaching in audio, the phases of the different frequencies (in a processed path and an unprocessed path) are unimportant, as the ear is insensitive to them. However, Applicant has found that there are indeed artifacts produced which detract from the quality of the output signal. By compensating for the delays due to the processing of the audio signal to generate the infrabass signals, prior to adding these infrabass signals to the input audio signal, these artifacts are eliminated.

The Sakata patent discloses a low frequency compensating circuit for audio signals which includes a fixed delay circuit.

In the subject invention, as claimed in claim 3, the delay means is controllable.

Applicant submits that Sakata teaches away from the subject invention as claimed in claim 3.

Further, Applicant submits that Sakata does not supply that which is missing from Watanabe et al., i.e., delaying an unprocessed audio signal in a second path by an amount to compensate for the delay of the audio signal subjected to the filter means and the creating means in a first signal path.

In view of the above, Applicant believes that the subject invention, as claimed, is neither anticipated nor rendered obvious by the prior art, either individually or collectively, and as such, is patentable thereover.

Applicant believes that this application, containing claims 1-4, is now in condition for allowance and such action is respectfully requested.

Respectfully submitted,

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On January 10, 2005

By Burnett James

INFRABASS

BACKGROUND OF THE INVENTION

Field Of The Invention

[0001] The invention relates to a bandwidth extension device.

[0002] The invention further relates to an audio reproduction system comprising such a bandwidth extension device.

Description Of The Related Art

[0003] Such a device is known from ~~the~~ European ~~patent~~ Patent ~~application~~ Application No. EP-A-0 240 286, corresponding to U.S. Patent 4,790,014.

[0004] To improve the aural sensation in low-pitched (this is ~~:~~, signals in the very low frequency band) sound reproduction by an audio reproduction system or the like, a sub-harmonics generator is used to create this low-pitched signal. In this way, a lower pitch signal is created than is present in the incoming signal.

SUMMARY OF THE INVENTION

[0005] It is an object of the invention to further improve such a bandwidth extension device ~~further~~.

[0006] To this end, a first aspect of the invention provide a bandwidth extension device comprising an input for receiving an input signal, a first signal path and a second signal path whereby

the first signal path comprises a filter means for filtering the input signal, creating means for creating an adapted signal with a lower frequency part than the input signal, combining means for combining the adapted signal of the first signal path with the input signal of the second signal path whereby the second signal path comprises between the input and the combining means delay means~~as defined in claim 1~~. A second aspect of the invention is to provide an audio reproduction system.

[0007] The invention is based on the ~~inside~~ fact that during the creation of the sub-harmonics, that part of the signal is delayed longer than the non-processed part of the signal. By combining these two signal parts in the combining means, prior art devices generate output signals which ~~have~~ consequently have artifacts.

[0008] By delaying the non-processed signal part, it is possible to compensate for the delay ~~both~~ in the processed signal part~~s~~ ~~equal~~ so ~~overcoming~~ as to overcome the artifacts generated in the output signals of the prior art device~~has~~s.

~~Embodiments of the invention are described in the dependent claims.~~

BRIEF DESCRIPTION OF THE DRAWING

[0009] The invention and additional features, which may optimally be used to implement the invention to advantage, will be apparent from and elucidated with a reference to the examples

described below and hereinafter and shown in the ~~figures. Herein shows~~accompanying drawing, in which:

[0010] Fig. 1~~, an example~~shows a block diagram of a bandwidth extension device according to the invention~~,~~; and

[0011] Fig. 2 ~~an example of~~shows a block diagram of an audio reproduction system according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] Fig. 1 shows ~~an example~~a block diagram of a bandwidth extension device BD according to the invention.
A bandwidth extension device can be used in an audio reproduction system to improve the aural sensation of the low-pitched signal-part.

[0013] At a first input IL, the device receives a left input signal, and at a second input IR, the bandwidth extension device receives a right input signal. Both inputs are coupled to a summing device SUM for ~~a~~ summing the both input signals ~~in this example~~. The output of the summing device SUM is coupled to a band-pass filter BPF1 for filtering the summed input signal to a certain predetermined low frequency part. The output of the band-pass filter BPF1 is coupled to a non-linear device NLD for creating an adapted signal with a low frequency part. ~~Herewith s~~Sub-harmonics of the lowest part of the input signal are created by the non-linear device NLD~~,~~ resulting in a lower pitch signal than is present in the incoming signal.

[0014] Reference is made to ~~the~~ non-prepublished European ~~application~~ Application ~~of the same applicant~~No. EP ~~application ref. Nr.~~ 00201509.7, corresponding to U.S. Patent Application Serial No. 09/841,958, filed April 25, 2001 (applicants ref. PHNL000249) owned by the Assignee of the subject application wherein the use of sub-harmonics generators is described in detail.

[0015] The output of the non-linear NLD is coupled to a second band-pass filter BPF2 for filtering out the non-required frequency part~~.~~.

The output of the band-pass filter BPF2 is coupled to a first combining device COM1 and to a second combining device COM2.

[0016] The first combining device COM1 receives, at a second input, a signal from an all-pass filter APF1 ~~which all-pass filter is coupled with its~~having an input coupled to the first input IL of the bandwidth extension device ~~IL.~~.

The second combining device COM2 receives, at the other input, a signal from a second all-pass filter APF2 ~~which receives at its~~having an input ~~a signal from~~coupled to the second input IR of the bandwidth extension device~~.~~.

The outputs of the first and second combining devices COM1 ~~respectively~~ and COM2 are coupled, respectively, to the first and second outputs OL and OR, respectively, of the bandwidth extension device ~~OL respectively OR~~.

[0017] By adding the all-pass filter APF1 and the all-pass filter APF2 ~~having~~, which have a certain delay, it is ~~made~~ now possible to combine, in the combining devices, ~~the~~ two signal parts with the same delay. This results in an improved output signal in comparison with prior art devices.

[0018] Instead of the all-pass filters, it is also possible to use a delay element ~~.~~ . Further, it is possible to use a controllable delay element which makes it possible to amend the delay in dependence ~~of~~ on the delay of the signal path through the band-pass filter BPF1, the non-linear device NLD and the band-pass filter BPF2.

[0019] Fig. 2 shows a block diagram of an audio reproducing system AS. The audio reproducing system AS includes an input I2 for receiving audio signals. A signal processing device SPD2 processes the audio signals in accordance with the desires of a user of the audio reproducing system AS. An output of the signal processing device SPD2 carrying the processed audio signals is applied to a bandwidth extension device BD2 as described above with reference to Fig. 1. Output signals from the bandwidth extension device BD2 are applied to output O2.

ABSTRACT~~:~~ OF THE DISCLOSURE

To improve the aural sensation of audio signals ~~the use of~~, a bandwidth extension devices is used in audio reproduction systems ~~is known~~.

~~Herewith it is possible to add~~ Such a bandwidth extension device enables the addition of a low-pitched signal to the audio signal, the low-pitched signal having a ~~comprising~~ lower signal part than the original input signal.

~~The invention~~ In order to ~~provides an improvement of the known devices to~~ overcome artifacts in the reproduced audio signal, the bandwidth extension device delays ~~by delaying~~ the unprocessed signal part to obtain the same delay as the processed signal part containing ~~obtained~~ sub-harmonics.

~~Fig. 1~~